

REMARKS

Claims 1-3, 5-13, 15-22, 25-34, 38-46, 49, and 50 are pending in the application. This Amendment currently amends claims 1, 5, 11, 15, 21, 29, and 42-45, and cancels without prejudice or disclaimer claims 4, 14, 23, 24, 35-37, 47 and 48. No new matter is added to currently amended claims 1, 5, 11, 15, 21, 29, and 42-45. Claims 1, 5, 11, 15, 21, 29, and 42-45 are currently amended to merely clarify the subject matter of the claims and in no way narrow the scope of the claims in order to overcome the prior art or for any other statutory purpose of patentability.

Notwithstanding any current claim amendments of the current Amendment or those amendments that may be made later during prosecution, Applicants' intent is to encompass equivalents of all claim elements. Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

Claims 43-45 stand rejected under 35 U.S.C. §112, first paragraph. Claims 5, 15, and 29 stand rejected under 35 U.S.C. §112, second paragraph.

Claims 1-3, 5-10, 21, 26-34, 38, 40, and 41 stand rejected under 35 U.S.C. §103(a) as obvious over U.S. Patent No. 6,252,254 to Soules et al. (hereinafter, Soules), in view of U.S. Patent No. 5,847,507 to Butterworth et al. (hereinafter, Butterworth) and U.S. Patent No. 5,798,536 to Tsutsui. Claims 11-13, 15-20, and 39 stand rejected under 35 U.S.C. §103(a) as unpatentable over Soules, Butterworth, and Tsutsui as applied to the claims above, and further in view of U.S. Patent No. 6,153,123 to Hampden-Smith et al. (hereinafter, Hampden-Smith). Claim 25 stands rejected under 35 U.S.C. §103(a) as unpatentable over Soules, Butterworth, and Tsutsui as applied to the claims above, and further in view of U.S. Patent No. 6,166,489 to Thompson et al. (hereinafter, Thompson). Claims 46, 49, and 50 stand rejected under 35 U.S.C. §103(a) as unpatentable over Soules, Butterworth, and Tsutsui as applied to the claims above, and further in view of U.S. Patent No. 6,340,824 to Komoto et al. (hereinafter, Komoto).

These rejections are respectfully traversed in view of the following discussion.

THE CLAIMED INVENTION

The claimed invention, as described in claim 1, is directed to a light-emitting

apparatus that comprises a primary light source including a GaN semiconductor light-emitting device that emits light of a wavelength of 380 nm to 500 nm, the GaN semiconductor light-emitting device including a single reflective layer disposed on a surface of a substrate on which no light-emitting layer is formed, and a transparent electrode disposed above the single reflective layer, and a secondary light source including a fluorescent material that comprises at least one of ZnS:Cu, Au, Al; ZnS:Cu, Al; ZnS:Cu; and $Y_2O_3S:Ce$, in which the fluorescent material absorbs light of a first wavelength, emitted by the primary light source, and emits light of a second wavelength, which is greater than the first wavelength.

The claimed invention, as described in claim 11, is directed to a light-emitting apparatus that comprises a primary light source including a GaN semiconductor light-emitting device that emits light of a wavelength of 380 nm to 500 nm, the GaN semiconductor light-emitting device including a single reflective layer disposed on a surface of a substrate on which no semiconductor layer is formed, and a transparent electrode disposed above the single reflective layer, and a secondary light source including a fluorescent material that comprises at least one of ZnS:Eu and $Y_2O_3S:Ce$, in which the fluorescent material absorbs light of a first wavelength, emitted by the primary light source, and emits light of a second wavelength, which is greater than the first wavelength.

The claimed invention, as described in claim 21, is directed to a light-emitting apparatus that comprises a first light source including a GaN semiconductor light-emitting device that emits blue light, the GaN semiconductor light-emitting device including a single reflective layer disposed on a surface of a substrate on which no semiconductor layer is formed, and a transparent electrode disposed above the single reflective layer, and a second light source including a first fluorescent material that absorbs light emitted by the first light source and emits green light, and a third light source that emits red light, in which the blue light emitted by the first light source, the green light emitted by the second light source, and the red light emitted by the third light source are mixed to thereby generate white light.

The claimed invention, as described in claim 42, is directed to a light-emitting apparatus that comprises a box including a bottom surface including a first electrode and a second electrode, a primary light source including a GaN semiconductor light-emitting device that emits light of a wavelength of 380 nm to 500 nm and is fixed to one of the first electrode and the second electrode, the GaN semiconductor light-emitting device including a single

reflective layer disposed on a surface of a substrate on which no light-emitting layer is formed, and a transparent electrode disposed above the single reflective layer, and a secondary light source including a fluorescent material that comprises at least one of ZnS:Cu, Au, Al; ZnS:Cu, Al; and ZnS:Cu, in which the fluorescent material absorbs light of a first wavelength, emitted by the primary light source, and emits light of a second wavelength, which is greater than the first wavelength.

An exemplary aspect of the present invention includes a transparent electrode disposed above the single reflective layer. The transparent electrode enhances the efficiency of light extracted from the GaN semiconductor light-emitting device.

Another exemplary aspect of the present invention allows the totality of light emitted from the light-emitting apparatus to be whiter than that of the blue-green light emitted by the GaN semiconductor light-emitting device because some of the blue-green light emitted by the GaN semiconductor light-emitting device is absorbed by a fluorescent material, which emits fluorescent light of a longer wavelength.

II. THE PRIOR ART REJECTIONS

A. The Soules Reference

Fig. 1 of Soules discloses a phosphor coated LED or light-emitting device 10 having a blue-emitting LED 12 covered with a phosphor containing layer or covering 14 and a clear polymer lens 16 (col. 3, lines 45-49). Fig. 2 shows a phosphor-coated LED or light-emitting device 10 having a blue-emitting LED 12 covered with a phosphor-containing layer or covering 15, and a clear polymer lens 16 molded over layer 15 (col. 3, lines 49-53).

Soules discloses that one example of a phosphor composition comprises at least one of the following green-emitting phosphors: $\text{YBO}_3\text{:Ce, Tb}$; $\text{BaMgAl}_{10}\text{O}_{17}\text{:Eu, Mn}$; and $(\text{Sr,Ca,Ba})(\text{Al,Ga})_2\text{S}_4\text{:Eu}$; in combination with at least one of the following red-emitting phosphors: $\text{Y}_2\text{O}_2\text{S:Eu, Bi}$; $\text{YVO}_4\text{:Eu, Bi}$; SrS:Eu ; $\text{SrY}_2\text{S}_4\text{:Eu}$; $\text{CaLa}_2\text{S}_4\text{:Ce}$; and $(\text{Ca,Sr})\text{S:Eu}$ (col. 4, lines 25-31).

B. The Butterworth Reference

Fig. 2 of Butterworth discloses a light emitting diode 200 having a lens containing a fluorescent dye (col. 2, lines 55 and 56). The blue emitting gallium nitride (GaN) die 110 is

attached and wire bonded into the reflector cup lead frame 120 (col. 2, lines 3-5).

C. The Tsutsi Reference

Fig. 1 of Tsutsi discloses a light-emitting semiconductor device that comprises a light-emitting chip 1 based on gallium nitride (GaN), a first electrode lead 3 have a planar surface for mounting thereon the light-emitting chip 1 through an adhesive 2, and a second lead which is of the same material as the first electrode lead and extending in parallel therewith (col. 4, lines 53-62).

Claims 1 and 21 recite at least the feature of "a transparent electrode disposed above said single reflective layer."

Nowhere does Soules, Butterworth and Tsutsi, either individually or in combination, disclose, teach or suggest the feature of "a transparent electrode disposed above said single reflective layer," as recited in claims 1 and 21. Therefore, Soules, Butterworth and Tsutsi do not provide the enhanced efficiency of light extracted from the GaN semiconductor light-emitting device, which is achieved by the present invention.

For at least the reasons outlined above, Applicants respectfully submit that Soules, Butterworth and Tsutsi, either individually or in combination, do not teach or suggest every feature of claims 1 and 21. Accordingly, Soules, Butterworth and Tsutsi, either individually or in combination, fail to render obvious the subject matter of claims 1 and 21, and claims 2, 3, 5-10, 26-34, 40, and 41, which depend from claims 1 and 21, under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 1-3, 5-10, 21, 26-34, 40, and 41 is respectfully solicited.

D. The Hampden-Smith Reference

Hampden-Smith discloses that preferred sulfur-containing phosphor host materials for some display applications include the metal sulfides, particularly the Group 12 metal sulfides (e.g., ZnS and CdS) (col. 35, lines 63-67). For such metal sulfides, preferred activator ions can be selected from the rare-earth elements (e.g., La, Ce, Pm, Eu, Gd, Tb, and Yb), preferably Eu or Tb.

In addition, oxysulfides, particularly Y₂O₂S:Eu and rare-earth oxysulfides such as Gd₂O₂S:Tb and La₂O₂S:Tb can also be produced col. 36, lines 58-60 and Table 1 of col. 37).

Claim 11 recites at least the feature of "a transparent electrode disposed above said single reflective layer; and a secondary light source including a fluorescent material that comprises at least one of ZnS:Eu and Y₂O₂S:Ce."

Hampden-Smith discloses various sulfur-containing phosphor powders, methods for making phosphor powders, and generalized devices incorporating the phosphor powders (Abstract, lines 1 and 2). Nowhere does Hampden-Smith teach or suggest a transparent electrode disposed above said single reflective layer, as recited in claim 11. Therefore, Hampden-Smith does not provide the enhanced efficiency of light extracted from the GaN semiconductor light-emitting device, which is achieved by the present invention.

As discussed above with respect to claims 1 and 21, which recite the identical feature of claim 11, underlined above, nowhere do Soules, Butterworth, and Tsutsi teach or suggest the feature of "a transparent electrode disposed above said single reflective layer."

In addition, nowhere does Hampden-Smith teach or suggest a fluorescent material that comprises ... Y₂O₂S:Ce.

For at least the reasons outlined above, Applicants respectfully submit that Soules, Butterworth, Tsutsi, and Hampden-Smith, either individually or in combination, fail to disclose every feature of claim 11. Accordingly, Soules, Butterworth, Tsutsi, and Hampden-Smith, either individually or in combination, fail to render obvious the subject matter of claim 11 and claims 12, 13, 15-19, and 39, which depend from claim 11, under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 11-13, 15-20, and 39 under 35 U.S.C. §103(a) as unpatentable over Soules, Butterworth, and Tsutsi in further view of Hampden-Smith is respectfully solicited.

E. The Thompson Reference

The Examiner cites Thompson as teaching a full-color LED assembly comprising two LEDs and a photolumiscent downconverter phosphor disposed for re-emission of a longer wavelength of light in response to light that is emitted from only one of the two LEDs, wherein the phosphor may either emit green or red light.

Claim 21 recites at least the feature of "a transparent electrode disposed above said single reflective layer."

Nowhere does Thompson disclose, teach or suggest the feature of "a transparent

electrode disposed above said single reflective layer," as recited in claim 21. Therefore, Thompson does not provide the enhanced efficiency of light extracted from the GaN semiconductor light-emitting device, which is achieved by the present invention.

As argued above in regard to the rejection of claims 21, 26-34, 40, and 41 under 35 U.S.C. §103(a) over Soules, Butterworth, and Tsutsi, nowhere do Soules, Butterworth, and Tsutsi teach or suggest the feature of "a transparent electrode disposed above said single reflective layer."

For at least the reasons outlined above, Applicants respectfully submit that Soules, Butterworth, Tsutsi, and Thompson, either individually or in combination, fail to disclose every feature of claim 21. Accordingly, Soules, Butterworth, Tsutsi, and Thompson, either individually or in combination, fail to render obvious the subject matter of claim 21 and claim 25, which depends from claim 21, under 35 U.S.C. §103(a). Withdrawal of the rejection of claim 25 under 35 U.S.C. §103(a) as unpatentable over Soules, Butterworth, and Tsutsi in further view of Thompson is respectfully solicited.

F. The Komoto Reference

The Examiner cites Komoto as teaching a GaN-based light emitter that preferably emits at wavelengths of 380 nm or less and which communicates with fluorescent materials for downconverting the primary light into various colors including white.

Claims 1 and 21 recite at least the feature of "a transparent electrode disposed above said single reflective layer."

Nowhere does Komoto disclose, teach or suggest the feature of "a transparent electrode disposed above said single reflective layer," as recited in claims 1 and 21. Therefore, Komoto does not provide the enhanced efficiency of light extracted from the GaN semiconductor light-emitting device, which is an aspect of the present invention.

As argued above in regard to the rejection of claims 1-3, 5-10, 21, 26-34, 40, and 41 under 35 U.S.C. §103(a) over Soules, Butterworth, and Tsutsi, nowhere do Soules, Butterworth, and Tsutsi teach or suggest the feature of "a transparent electrode disposed above said single reflective layer."

For at least the reasons outlined above, Applicants respectfully submit that Soules, Butterworth, Tsutsi, and Komoto, either individually or in combination, fail to disclose every

feature of claims 1 and 21. Accordingly, Soules, Butterworth, Tsutsi, and Komoto, either individually or in combination, fail to render obvious the subject matter of claims 1 and 21 and claims 46, 49, and 50, which depends from claims 1 and 21, under 35 U.S.C. §103(a). Withdrawal of the rejection of claim 25 under 35 U.S.C. §103(a) as unpatentable over Soules, Butterworth, and Tsutsi in further view of Komoto is respectfully solicited.

III. CONCLUSION

In view of the foregoing, Applicants submit that claims 1-3, 5-13, 15-22, 25-34, 38-46, 49, and 50, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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Peter A. Balnave
Peter A. Balnave
Reg. No. 46,199

McGinn & Gibb, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254